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ATITUDE PARA A TECNOLOGIA PARA PROFESSORES DE CIÊNCIA EM TREINAMENTO NA INDONÉSIA: UMA ANÁLISE DE FATOR EXPLORATÓRIO

ATTITUDE TOWARDS TECHNOLOGY FOR SCIENCE INDONESIA:

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RESUMO

O conhecimento e a habilidade tecnológica são cruciais para professores e professores em treinamento, pois afetam diretamente o desempenho, a qualidade da aprendizagem e o acesso mundial mais amplo. Muitos estudos mostraram que a capacidade de um professor em pedagogia integrada à tecnologia é influenciada por sua atitude em relação à tecnologia. O objetivo deste estudo foi utilizar a análise fatorial exploratória para examinar os fatores estruturais, o nível de preferência e a inter-relação entre os componentes da atitude em relação à tecnologia. Os dados foram coletados de 150 professores de ciências em serviço da Universidade Lampung usando o método tradicional de pesquisa. Além disso, foram analisadas variância, comparação de valores médios e coeficientes de Alfa de Cronbach para explicar as contribuições de itens e fatores para a atitude geral em relação à tecnologia. A análise de correlação de Pearson também foi realizada para descobrir a relação entre os componentes. Os resultados confirmaram a validade do instrumento com fatores de carga variando de 0,427 a 0,882. Além disso, o coeficiente total de Cronbach Alpha foi de 0,810, o que informou uma alta consistência interna do instrumento, com cinco componentes de atitude tecnológica, responsáveis por 77,82% da variância. Especificamente, a consequência percebida da tecnologia é identificada como uma preferência atitudinal dominante dos professores de ciências em serviço na Indonésia, seguidos pelas aspirações de carreira e pela diferença de gênero. A análise do momento do produto Pearson revelou uma correlação significativa entre os componentes da atitude em relação à tecnologia.

Palavras-chave: *Atitude em relação à tecnologia; Professor de ciências em treinamento; Análise fatorial exploratória.*

ABSTRACT

Technological knowledge and skill are crucial for teachers and pre-service teachers because they have a direct effect on performance, learning quality, and wider world access. Many studies showed that the ability of a teacher in technology-integrated pedagogy is influenced by their attitude towards aim exploratory factor analysis in examining the structural factors, the preference level and the interrelationship among components of attitude towards technology. Data was collected from 150 pre-service science teachers in Lampung University by using traditional survey method. Additionally, variance, mean values comparison, and Cronbach Alpha coefficients were analyzed in explaining the contributions of items and factors to the overall attitude towards technology. analysis conducted find out among components. results confirmed the validity of instrument with loading factors ranging from 0.427–0.882. In addition, the total Cronbach Alpha coefficient was 0.810 which informed a high internal consistency of instrument with five components of technological attitude account for 77.82% of variance. Specifically, the perceived consequence of technology is identified as a dominant attitudinal preference of pre-service science teachers in Indonesia, followed by career aspirations and gender difference. Pearson product-moment analysis revealed a significant correlation among components of attitude towards technology.

Keywords: *Attitude toward technology; Pre-service science teacher; Exploratory factor analysis.*

development a major concern for all elements of society. People in any profession are aware of the great role) of ease life national development. In education, ICT mastery is prominent for teachers and pre-service professional teachers . (Warschauer & Matuchniak, 2010). The integration of ICT in learning is an essential strategy in facilitating the shifting from traditional pedagogical paradigms towards constructivist-oriented pedagogies (Chai, Hong & Teo, 2009; Liu, 2011; Keengwe & Georgina, 2013).

By integrating technology, teachers can easily direct students to imagine the complex objects (Tania & Saputra, 2018; Tania et al., 2017; Sang et al., 2010), interpret the abstract concept to concrete things (Sunyono, Tania, & Saputra, 2016; Lee, 2012; Bujak et al., 2013; Wojciechowski & Cellary, 2013), also actively participate in collaborative activities in virtual classes or e-learning schemes (Holcomb & Beal, 2010, Keengwe et al., 2014). The use of various innovations and technology by teachers will lead to higher confidence in integrating technology-pedagogy (Kim), facilitating collaboration between colleagues (Afshari ; Ottenbreit-Leftwich ; Kim ; Tomkins, 2019), and bringing up new innovative ideas (Koehler & Mishra, 2009; ayer, 2012; Laurillard, 2013). Finally, the and multimedia process students enhance their academic achievement (Chiang, Yang, & Hwang, 2014; Alqahtani & Mohammad, 2015) and encouraging students' motivation and confidence in learning (Hazari, North, & Moreland, 2009; Yang & Wu, 2012; Chiang, Yang, & Hwang, 2014).

Recognizing the important role of technology in achieving learning objectives, a professional teacher must take , guiding, motivating in accomplishment ICT-integrated learning (Kramarski & Michalsky, 2010; Gilakjani, Lai-Mei, & Ismail, 2013). A research conducted by Hattie (2003) revealed that teacher's effectiveness contributes , 50% of variance for pre-existing student abilities, and the remaining 20% of variance is influenced by home, school (including administration), and peers. Based on this data, teachers who use student-centered approaches and have good classroom management competencies will increase student achievement to the maximum (Opdenakker & Van Damme, 2006). Furthermore, a competent teacher is characterized by how often she/he uses ICT in multiple ways in the classroom (Whittle Telford, & Benson, 2018).

There are a couple of factors for teachers in integrating ICT into their learning which can be categorized as external and internal factors. External factors include professional teacher environments, , and (influences ((Baek, Jong, & Kim, 2008) are also included as external factor. Meanwhile, internal factors include (Eteocleous,), individual mindset and teacher's belief (Liu, 2011).

Attitude is undeniably internal greatly technology integration in teaching- . Teo (2008) states that the way teachers use technology for instructional design is very dependent on their attitude toward technology. Despite of the qualified technological tools provided by the school provid it can only be optimized if the teacher has). A positive teacher attitude towards technology will be a determining fac for the successful adoption and integration process (Van Braak ; uang & Liaw, 2005). Conversely, teachers who negative will be difficult accept adapt technology in their instructional design (Wang & Dostál, 2017).

In particular, Bame et (1993) has constructed structural factors of

USA ( ) Survey (de Vries, 1988). Items of PATT-US are grouped into 5 dimensions i.e. in Schools, Consequences , Difficulty Perception, Both Genders (Bame et al., 1993). However, Ardies, de Maeyer, & Gijbels (2013) reconstructed the PATT-survey by adding one more dimension in the mediated boredom of technology. By using this PATT-reconstructed survey, this research investigated attitude towards technology of pre-service Indonesian science teachers. Furthermore, information related to the structural factors was used to discuss the preference level of students towards factors and interrelationship among factors.

Research and Participants

research used conventional survey design by distributing questionnaires to pre-service sci e teacher in Lampung Province, Indonesia. in which conducts of the sample , behavior or (Creswell, 2012). Furth more, methods have been effectively express technology implementation teaching and learning (Norton, McRobbie, & Cooper, 2000; Baek, Jong, & Kim, 08). The population in this research was science Chemical , Physical Education, and Biological addition, 150 pre-service science teachers were chosen as research sample by using random sampling technique. Everyone who became a sample filled agreement to participate in this research.

2.2 Instrument and Data Collection

The data collection technique in this research was using attitude towards technology questionnaire (Appendix 1) developed by Ardies, de Maeyer, & Gijbels (2013) which originally consisted of 25 items. The instrument was adapted and transliterated into the Indonesian language (Bahasa), making it easier for research subjects to understand each item in the instrument. Items are then consulted and validated by the judgement of three experts in the field of statistics, psychologists, and education evaluation experts. Furthermore, all items were inserted into google form to facilitate participants in accessing the questionnaire and to simplify the data tabulation.

this into several stages. initial , students' answers were coded into 5 levels of Likert scale. The coding results were analyzed ether the data was suitable for EFA based on -Mayer-) sampling . Before EFA process was carried out, the communality coefficient of each item identified would be considered as included in the analysis based on Stevens's (2002) criteria. Items that are maintained in the instrument must have a loadin factor of more than 0.40, therefore items with of will automatically be in the analysis of each item in the instrument. If all of these preliminary procedures have been passed then an EFA can be performed. The estimation of latent factors number proposed in this study was obtained by extracting the main components and of the varimax orthogonal rotation by cons ring an eigenvalue which is greater than one. obtain the each factor total coefficient was used to calculate the validated construction instrument. In addition, the mean and standard deviation were calculated to obtain information related to the dominant preference for the factors forming the technology attitude. In the final stage, co ation analysis of each factor was carried out

Structural analysis attitude towards technology

The results of this study (a) structure analysis of attitude towards technology and (b) level of preference and interrelationship between attitude dimensions. Structure analysis was carried out by using exploratory factor analysis in which statement items in the questionnaire will be grouped and validated into certain fac s based on appropriate statistical criteria. a statistical method reveal basic variables and identify fundamental relationships between variables.

All measured variables correspond with each latent variable (Schmitt, 2011; Treiblmaier & Filzmoser, 2010). To ensure th EFA results, calculation to Kayser-Mayer- . The KMO was performed to analyze measuring the lower the the c . Moreover, Bartlett check was . This method was able to inform variables whic were not related and suitable for structural

KMO and values in this study were 0.853 and 2157.349 ($p < 0.05$) respectively, which indicate that a set of research data was suitable for EFA and would produce accurate analysis results. Subsequently, it was necessary to inspect whether all items could be included in the EFA analysis or need to eliminate certain items in the analysis process. This could be done by observing the coefficient of extraction commonalities. Extraction communalities are estimations of variance for a factor solution (UCLA Statistical Consulting Group, 2019). Small values of the commonalities coefficient indicated that variables did not match factor solutions, and may considered to be excluded from the next analysis. Steven (2002) suggested that the threshold value of the communality was 0.40 to determine which items were retained or excluded in EFA. The communality coefficient was greater than 0.40 indicates that the item contributed significantly to latent variables in producing a fit model. Furthermore, item number 10 (I enjoy repairing things at home) has a coefficient of 0.318, it means that the commonality analysis needs to be repeated by removing the item. In the second commonality analysis, it was obtained coefficients ranging from 0.410 – 0.852 which informed that only 23 items could be considered for the EFA analysis.

The verified items were further analyzed by using varimax rotation method and principal component extraction with eigenvalues larger than one for all accepted factors. The results suggested that items wer distributed into 5 latent factors with 77.82% of (s^2) 1. construction different from the result of Ardies et al. (2013) who obtained six factors of technological attitude. The current study found out that the items concerning interest in technology proposed by Ardies's research spread to two factors, namely technological career aspirations and consequence of technology. Full details of the factors are presented as follows:

1. Factor 1 (s^2 = 18.972%) was named technological career aspirations (TCA). It accommodated 6 items exploring job and career ambition in technology, interest concerning work in technology, and interest concerning technology lesson at school.
2. Factor 2 (s^2 = 16.581%) was named as perceived consequence of technology (PCT). It accommodates 6 items exploring the importance of technology and technology lessons, the advantage of technological use at work, interest in technology and technology lessons at school.
3. Factor 3 (s^2 = 13.093%) was named as tediousness towards technology (TTT). It accommodates 4 items exploring technological jobs, hobbies, and machines are boring.
4. actor 4 (s^2 = 15.554%) was named both (TBG). It accommodates 3 items exploring gender differences in technology.
5. Factor 5 (s^2 = 13.620%) was named as label perceived difficulty of technology (PDT). It accommodates 4 items exploring prerequisites to study technology.

Each item has an absolute value of the loading factor ranging from 0.427–0.882 as shown in table 2. This value meets the criteria of Steven (2002) whe s items retained in factor analysis must have .4. This result also supported by analysis using Cronbach's alpha coefficients, while the scores for each factor are 0.753, 0.861, 0.830, 0.796 and 0.755, respectively with 0.810 as the overall coefficient. These indicate that the loading factors have a high internal consistency to evaluate attitudes of teachers' candidates towards technology.

3.2 Preference level and Interrelationships among factors

The preference level analysis was carried out to get specific information related to the dominant attitudinal tendency of pre-service science teachers towards technology in Indonesia. This analysis was performed by comparing the mean values of each factor with a grand mean as suggested by Suprapto (2016). The result of the analysis claimed that the

perceived consequence of technology was considered as the most dominant factor from technology attitude value .013 a .468. second rank was technological career aspirations value 3.885 a value .681, technology as subject for both boys and girls with mean and standard deviation values of 3.080 and 1.127 respectively. These three factors had a mean value greater than the grand mean (2.960) as shown in Table 2. These findings indicated that pre-service Indonesian science teachers, in the st stage, would direct their feelings toward the of technology when they decided to use or not to use technology in their instructional design. Subsequently, teacher candidates would consider how big their ambition to learn or to master technology-related jobs in the future, by including their gender aspects (Ardies et al., 2014).

The next important information is regarding the relationships among attitudinal factors towards technology. In this study, the interrelationship among factors was analyzed using . Pearson correlation test one-on-one correlation between each toward correlation coefficients are ranging from -0.208–0.538 that useful for limited prediction (Creswell, 2012). Furthermore, one factor correlates significantly at the 0.01 and 0.05 levels with other factors items questionnaire affect each other either positively or negatively. This also indicates that the efforts applied to improve an attitude component will directly strengthen or weaken another component.

This study was performed by analyzing structural factors which composed technological attitudes, followed by revealing the preference level and interrelationship among factors. These findings produce an attitude towards technology instrument which has high validity and reliability. The items and latent factors in this instrument were able to explain 77.82% of variance in attitudes towards technology. This percentage of variance meets the standard by Pett, Lackey, & Sullivan (2003) which revealed the cumulative variance extracted by successive factors should be more than 50%. Moreover, variance analysis in each factor was found that technological career aspirations as the greatest variance among others. It means that the attitude towards technology could be described by job and career ambition in technology, interest relating to work in technology, interest relating to technology lessons at school relatively more than others. As in the reliability analysis, was .753; .861; .830; .796; .755 for each scale and 0.810 for the instrument overall. According to Nunnally & Bernstein (1994), the alpha values greater than 0.70 could be considered as a minimum measure of internal consistency. In other words, these factors were quite reliable in representing the overall attitudes towards technology. Based on the reliability and validity analysis above, the instrument was believed to be able to produce accurate information about attitude towards technology, especially for teachers and pre-service science teachers.

Preference level analysis based on the comparison between mean and grand mean informed three main factors of the technological attitudes for Indonesian science teacher candidates. There were perceived consequence of technology as the first rank followed by technological career aspirations, and both , respectively. As stated by Suprapto (2016), the comparison between mean and grand mean provide justification related to the degree of attitude (Suprapto, 2016). These results indicate that the pre-service teacher's attitude towards technology is primarily determined by their awareness importance technology benefits use, lessons schools. finding in line with by Sheingold& Hadley (1990) and found their teaching learning were the benefits own as teacher. Furthermore, interest in technology would encourage users to intensively interact with technology and explore the use of technology in various situations (Zhao & Frank, 2003). computer were show computers (Pope-Davis &Twing, 1991; Moseley and Higgins, 1999; Rozell& Gardner, 1999; Kadijevich&Haapasalo, 2008; Teo, 2008). The next technology attitudes of pre-service science teachers were job and career ambition, interest relating to work, and gender effect in technology. Ardies, Maeyer, &Gijbels (2015), researchers in specific, have studied these factors in their longitudinal studies and concluded that career aspirations and interests in technology depends on gender and become big boosts in addressing

technology integration. In addition, students' career aspirations and interests technology are unsettled, it generally changes and continues to decrease over time.

Pre-service teachers trained in Institutions for Teacher Training and Pedagogy would generally obtain courses related to content and professional knowledge integrated technology. For example ICT-based learning, virtual-based learning (e-learning), computer visualization, and various computer applications for specific subjects (for example computational chemistry, computational physics, bioinformatics, etc.). The aims were to introduce, train, and familiarize science teacher candidates in Indonesia adapt . Positive attitudes and confidence in integrating various technologies in instructional settings were expected by having more interactions and experiences with computer technology. This was also supported by Teo 08) who surveyed the attitude of Singaporean years use and level confidence.

From Pearson correlation analysis, it was found that a factor correlated to each other significantly with confidence levels of 99% and 95%. These results informed that career aspirations affect perceived consequence, tediousness, perceived difficulty toward technology and all these factors could not be separated from gender difference. Several studies supported these findings by stating that attitude towards computer technology constitutes to many variables such as computer experience (Pope-Davis & Twing, 1991; Kadijevich & Haapasalo, 2008; Teo, 2008), ; Teo, 2008), Age (Pope-Davis &Twing, 1991), gender (Pope-Davis &Twing, 1991; Sadik, 2006; Teo, 2008), training (Tsitouridou & Vryzas, 2003), and subjective norm and facilitating conditions (Teo, 2008). Therefore, all efforts by education stakeholders such as schools, government, education observers, institutions for educational quality assurance, teacher training institutions should start encouraging technology-pedagogy egration and improving technological skills for science by encouraging . Surely, many other factors must be also considered in doing this.

4. CONCLUSIONS:

Exploratory factor analysis applied in this research provided important evidence related to the main factors that characteristically configures the attitudes of pre-service science teachers towards technology. From all factors, perceived consequence of chnology, technological career aspirations, and both play an important role in attitude towards technology for Indonesian pre-service science teachers. Based on Cronbach alpha coefficients, there are significant attitudinal correlations among the factors. Finally, statistical judgments confirm that the instruments used in this study have a high validity and reliability. In addition, the evidence presented in this research are expected to be recommendations ar catalyst for teachers and teacher candidates mindset encourage a towards technology in education.

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Table 1. *Items informations, loading factor dan Cronbach α of attitude towards technology questionnaire*

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1: Technological Career Aspirations (TCA), α = 0.753, s^2 = 18.972%					
TCA1	0.879				
TCA2	0.850				
TCA3	0.801				
TCA4	0.798				
TCA5	0.645				
TCA6	0.492				
Factor 2: Perceived Consequence of Technology (PCT), α = 0.861, s^2 = 16.581%					
PCT1		0.847			
PCT2		0.800			
PCT3		0.789			
PCT4		0.529			
PCT5		-0.427			
PCT6		-0.482			
Factor 3: Tediousness Towards Technology (TTT) α = 0.830, s^2 = 13.093%					
TTT1			0.844		
TTT2			0.840		
TTT3			0.830		
TTT4			0.700		
Factor 4: Technology as a Subject for both Boys and Girls (TBG) α = 0.796, s^2 = 15.554%					
TBG1				0.882	
TBG2				0.881	
TBG3				0.815	
Factor 5: Perceived Difficulty of Technology (PDT), α = 0.755, s^2 = 13.620%					
PDT1					0.758
PDT2					0.724
PDT3					0.656
PDT4					0.606

Table 2. *The mean and standard deviation of each factor**

Factor	Mean	Standard Deviation	Ranking
1	3.885	0.681	2*
2	4.013	0.468	1*
3	1.924	0.781	4
4	3.080	1.127	3*
5	1.899	0.682	5

*mean > grand mean

Table 3. *Summary of Pearson correlation for each factors*

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1	1	0.538**	-0.403**	-0.216**	-0.273*
Factor 2		1	-0.249**	0.210*	-0.208*
Factor 3			1	0.253**	0.323**
Factor 4				1	0.345**
Factor 5					1

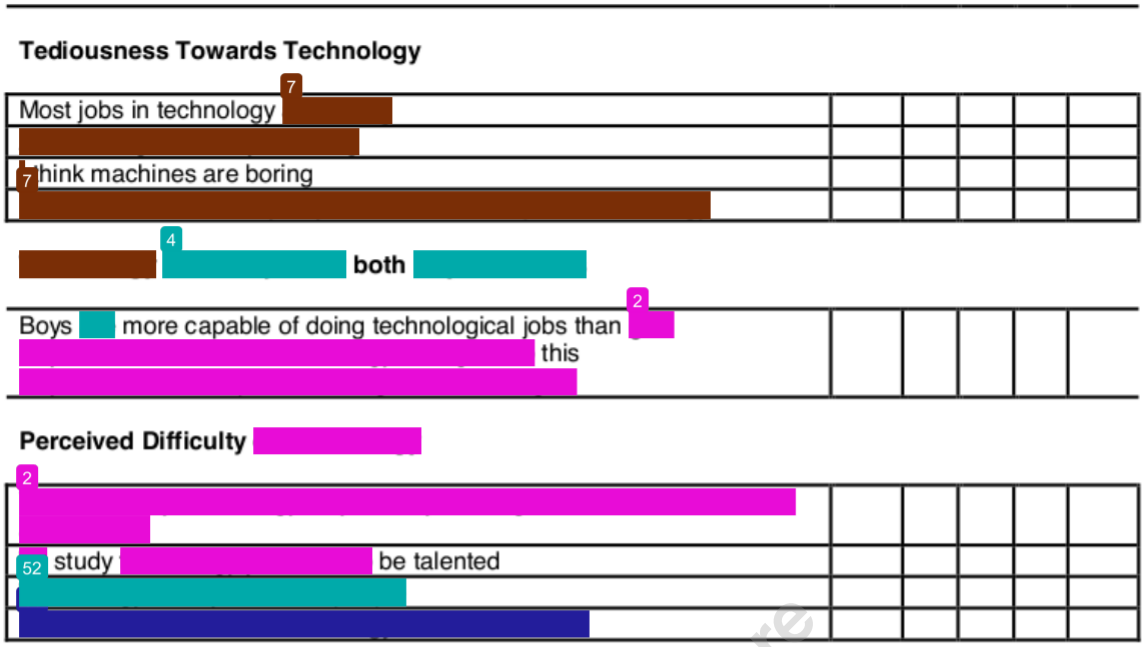
**$P > 0.01$; *$P > 0.05$

APPENDIX 1

Attitude Towards Technology Questionnaire

Directions:
Please tick () in the box one of the five choice ( ) for each

Items	Option
Technological Career Aspirations	
I would enjoy	
Consequence of	
echnology lessons are important	
makes everything work better	



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